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Twin Buttes Reservoir
Tom Green County, Texas

National Eutrophication Survey, Corvallis, Oreg

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REPORT
ON
TWIN BUTTES RESERVOIR
TOM GREEN COUNTY
TEXAS
EPA REGION VI
WORKING PAPER NO. 666

WITH THE COOPERATION OF THE
TEXAS WATER QUALITY BOARD
AND THE
TEXAS NATIONAL GUARD
MARCH, 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Texas Water Quality Board for professional involvement, to the Texas National Guard for conducting the tributary sampling phase of the Survey, and to those Texas wastewater treatment plant operators who voluntarily provided effluent samples.

Hugh C. Yantis, Jr., Executive Director of the Texas Water Quality Board, and John B. Latchford, Jr., Director, and the staff of the Field Operations Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Thomas Bishop, the Adjutant General of Texas, and Project Officer Colonel William L. Seals, who directed the volunteer efforts of the Texas National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

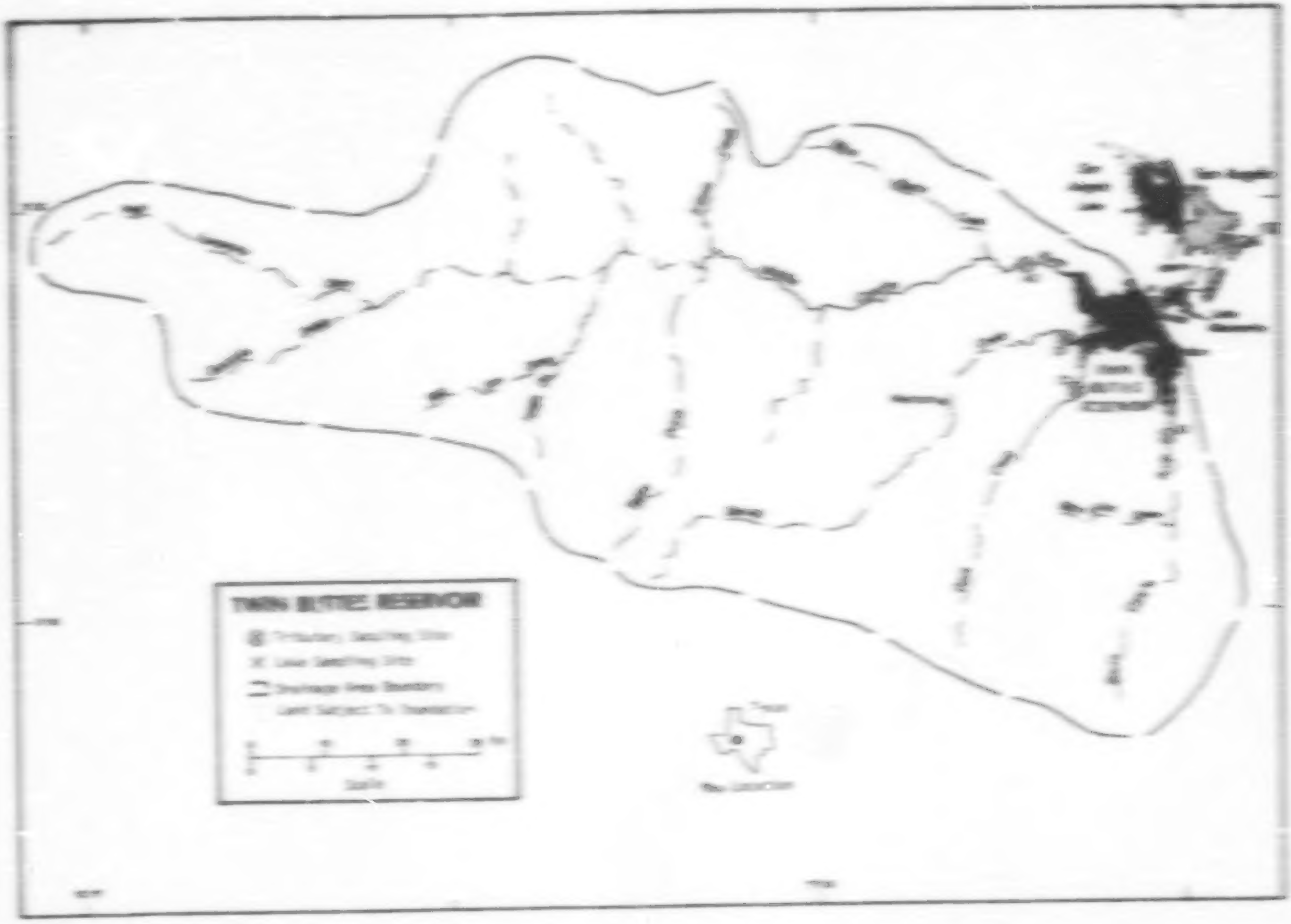
NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Texas

NAME	COUNTY
Amistad	Val Verde
Bastrop	Bastrop
Belton	Bell, Coryell
Braunig	Bexar
Brownwood	Brown
Buchanan	Burnet, Llano
Caddo	Harrison, Marion, TX; Caddo Parish, LA
Calaveras	Bexar
Canyon	Comal
Colorado City	Mitchell
Corpus Christi	Jim Wells, Live Oak, San Patricio
Diversion	Archer, Baylor
Eagle Mountain	Tarrant, Wise
Fort Phantom Hill	Jones
Houston	Harris
Kemp	Baylor
Lake O'The Pines	Camp, Marion, Morris, Upshur
Lavon	Collin
Lewisville (Garza-Little Elm)	Denton
Livingston	Polk, San Jacinto, Trinity, Walker

Lyndon B. Johnson	Burnet, Llano
Medina	Bandera, Medina
Meredith	Hutchinson, Moore, Potter
O. C. Fisher (San Angelo)	Tom Green
Palestine	Anderson, Cherokee, Henderson, Smith
Possum Kingdom	Palo Pinto, Stephens, Young
Sam Rayburn	Angelina, Jasper Nacogdoches, Sabine, San Augustine
Somerville	Burleson, Lee, Washington
E. V. Spence	Coke
Stamford	Haskell
Stillhouse Hollow	Bell
Tawakoni	Hunt, Rains, Van Zandt
Texoma	Cooke, Grayson TX; Bryan, Johnston, Love, Marshall, OK
Travis	Burnet, Travis
Trinidad	Henderson
Twin Buttes	Tom Green
White River	Crosby
Whitney	Bosque, Hill
Wright Patman (Texarkana)	Bowie, Cass


TWIN BUTTES RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Land Subject To Inundation
Scale
Texas
Map Location

TWIN BUTTES RESERVOIR

STORET NO. 4837

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Twin Buttes Reservoir is eutrophic; i.e., well supplied with nutrients and quite productive. Whether nutrient enrichment is beneficial or deleterious depends on the actual or potential effect on the uses of the reservoir. In this regard, no nuisance conditions are known to personnel of the Texas Water Quality Board and there is little or no impairment of the designated beneficial uses of this water body.

Twin Buttes Reservoir ranked nineteenth in overall trophic quality when the 39 Texas reservoirs sampled in 1974 were compared using a combination of six parameters*. Fifteen of the reservoirs had less and one had the same median total phosphorus, 11 had less and six had the same median dissolved phosphorus, 29 had less and two had the same median inorganic nitrogen, 15 had less mean chlorophyll a, and 16 had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at sampling stations 1 and 2 in August.

Survey limnologists did not observe macrophytes or surface concentrations of algae in the reservoir.

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* See Appendix A.

B. Rate-Limiting Nutrient:

The results of the algal assay indicate Twin Buttes Reservoir was phosphorus limited at the time the sample was taken (03/04/74). The reservoir data indicate phosphorus limitation in March and May but nitrogen limitation in October.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial point sources impacted Twin Buttes Reservoir during the sampling year.

There are no lakeshore septic tanks because construction of shoreline dwellings is prohibited*.

Based on the reservoir morphometry at the conservation-pool level, the present phosphorus loading of 0.04 $g/m^2/yr$ is a little less than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as an oligotrophic loading (see page 14). However, records for water year 1975 (October 1, 1974, through September 30, 1975) show that the mean reservoir content was less than the conservation pool capacity**. Therefore, the actual areal loading could have been greater than the indicated 0.04 g/m^2.

2. Non-point sources--The entire phosphorus input to Twin Buttes Reservoir was contributed by non-point sources during the sampling year. The Middle Concho River contributed 10.3% of the total; the South Concho River, 18.7%; and Spring Creek added 16.5%. The minor tributaries and immediate drainage contributed an estimated 13.2%.

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*Koederitze, 1976.
** Anonymous, 1976.

The phosphorus export rates of the three tributaries were less than 1 kg/km^2/yr (see page 13) and compare well with the rate of the North Concho River, a tributary of nearby O. C. Fisher Reservoir* (also less than 1 kg/km^2/yr).

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* Working Paper No. 656.

II. RESERVOIR AND DRAINAGE BASIN CHARACTERISTICS[†]

A. Morphometry (at conservation-pool level)[††]:

1. Surface area: 36.50 kilometers^2.
2. Mean depth: 6.3 meters.
3. Maximum depth: >13.1 meters.
4. Volume: 229.676 x 10^6 m^3.
5. Mean hydraulic retention time: 14.9 years (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Middle Concho River	3,576.8	0.205
South Concho River	922.0	0.420
Spring Creek	1,025.6	0.324
Minor tributaries & immediate drainage -	1,033.2	0.296
Totals	6,557.6	1.245

2. Outlet -

Middle Concho River	6,594.1**	0.489**

C. Precipitation***:

1. Year of sampling: 63.8 centimeters.
2. Mean annual: 44.5 centimeters.

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† Table of metric conversions--Appendix B.
†† Anonymous, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of reservoir; lesser outflow due to evaporation (Yost, 1976).
*** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Twin Buttes Reservoir was sampled four times in 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at three stations on the reservoir (see map, page vi). During each visit, a single depth-integrated (4.6 m to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first visit, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll *a* analysis. The maximum depths sampled were 13.1 meters at station 1, 12.8 meters at station 2, and 7.3 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table (the August nutrient samples were not preserved properly and were not analyzed).

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR [illegible] RESERVOIR
STORET CODE [illegible]

	1ST SAMPLING ([illegible])			2ND SAMPLING ([illegible])			3RD SAMPLING ([illegible])		
	[illegible] SITES			[illegible] SITES			[illegible] SITES		
PARAMETER	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]
DISS OXY (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]
CNDCTVY (MCROMO)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]
PH (STAND UNITS)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]
TOT ALK (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	-----	-----	-----
TOT P (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	-----	-----	-----
ORTHO P (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	-----	-----	-----
NO2+NO3 (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	-----	-----	-----
AMMONIA (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	-----	-----	-----
KJEL N (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	-----	-----	-----
INORG N (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	-----	-----	-----
TOTAL N (MG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	-----	-----	-----
CHLRPYL A (UG/L)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]
SECCHI (METERS)	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]	[illegible] - [illegible]	[illegible]	[illegible]

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR TWIN BUTTES RESERVOIR
STORET CODE 4827

4TH SAMPLING (10/29/74)

PARAMETER	3 SITES RANGE			MEAN	MEDIAN
TEMP (C)	17.3	-	18.7	18.4	18.5
DISS OXY (MG/L)	3.2	-	7.2	5.7	5.8
CNDCTVY (MCROMO)	372.	-	418.	388.	392.
PH (STAND UNITS)	7.6	-	7.9	7.8	7.7
TOT ALK (MG/L)	122.	-	124.	123.	124.
TOT P (MG/L)	0.037	-	0.082	0.052	0.044
ORTHO P (MG/L)	0.023	-	0.056	0.038	0.029
NO2+NO3 (MG/L)	0.210	-	0.290	0.254	0.250
AMMONIA (MG/L)	0.020	-	0.140	0.092	0.090
KJEL N (MG/L)	0.400	-	0.600	0.523	0.500
INORG N (MG/L)	0.240	-	0.430	0.332	0.290
TOTAL N (MG/L)	0.660	-	0.870	0.777	0.770
CHLRPYL A (UG/L)	2.2	-	11.3	6.4	6.0
SECCHI (METERS)	0.9	-	1.2	1.1	1.2

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
03/04/74	1. *Scenedesmus* sp.	1,650
	2. *Synedra* sp.	1,317
	3. *Ankistrodesmus* sp.	809
	4. *Oocystis* sp.	324
	5. Chrysophytan cells	194
	Other genera	1,403
	Total	5,697
05/15/74	1. *Scenedesmus* sp.	1,594
	2. *Chroomonas* sp.	1,593
	3. *Ankistrodesmus* sp.	474
	4. *Raphidiopsis* sp.	271
	5. *Pediastrum* sp.	237
	Other genera	848
	Total	5,017
08/05/74	1. *Raphidiopsis* sp.	13,554
	2. Flagellates	1,055
	3. *Synedra* sp.	506
	4. *Merismopedia* sp.	469
	5. *Carteria* sp.	430
	Other genera	2,147
	Total	18,241
10/29/74	1. *Cryptomonas* sp.	977
	2. *Chroococcus* sp.	821
	3. Centric diatoms	396
	4. *Ankistrodesmus* sp.	283
	5. *Dactylococcopsis* sp.	255
	Other genera	481
	Total	3,113

B. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
03/04/74	1	6.4
	2	5.8
	3	3.2
05/15/74	1	4.6
	2	7.7
	3	8.0
08/05/74	1	13.7
	2	12.4
	3	16.2
10/29/74	1	8.0
	2	7.2
	3	11.3

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	<0.005	0.290	0.1
0.050 P	<0.055	0.290	6.4
0.050 P + 1.0 N	<0.055	1.290	14.9
1.0 N	<0.005	1.290	0.1

2. Discussion -

The control yield of the assay alga, *Selenastrum capricornutum*, indicates that the potential primary productivity of Twin Buttes Reservoir was low at the time the sample was collected (03/04/74). No significant growth response occurred when only nitrogen was added, but there was an increase in yield when only phosphorus was added. These results indicate the reservoir was phosphorus limited at that time.

The reservoir data indicate phosphorus limitation in March and May but nitrogen limitation in October. The mean inorganic nitrogen to orthophosphorus ratios at those times were 32 to 1, 32 to 1, and 10 to 1, respectively.

IV. NUTRIENT LOADINGS

(See Appendix E for data)

For the determination of nutrient loadings, the Texas National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff months of April and May when two samples were collected. Sampling was begun in September, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Texas District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the means of the nutrient loads, in kg/km²/year, at stations A-2, B-2, and D-1 and multiplying the means by the ZZ area in km².

No known wastewater treatment facilities impacted Twin Buttes Reservoir during the sampling year.

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* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Middle Concho River	160	10.3
South Concho River	290	18.7
Spring Creek	255	16.5
b. Minor tributaries & immediate drainage (non-point load) -	205	13.2
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	640	41.3
Total	1,550	100.0

2. Outputs -

Lake outlet - Middle Concho River	625

3. Net annual P accumulation - 925 kg.

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* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Middle Concho River	10,220	9.2
South Concho River	15,455	13.9
Spring Creek	29,245	26.3
b. Minor tributaries & immediate drainage (non-point load) -	16,875	15.2
c. Known municipal STP's - None	-	-
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	39,405	35.4
Total	111,200	100.0

2. Outputs -

Lake outlet - Middle Concho River 16,470

3. Net annual N accumulation - 94,730 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Middle Concho River	<0.1	3
South Concho River	0.3	17
Spring Creek	0.2	29

E. Mean Nutrient Concentrations in Ungaged Stream:

Tributary	Mean Total P (Conc. (mg/l)	Mean Total N Conc. (mg/l)
Dove Creek	0.016	3.357

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* See Working Paper No. 175.

F. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.04	0.03	3.0	2.5

Vollenweider phosphorus loadings (g/m^2/yr) based on mean depth and mean hydraulic retention time of Twin Buttes Reservoir at conservation-pool level:

"Dangerous" (eutrophic loading)	0.12
"Permissible" (oligotrophic loading)	0.06

V. LITERATURE REVIEWED

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VI. APPENDICES

APPENDIX A

LAKE RANKINGS

19

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P
4801	AMISTAD LAKE	0.013	0.580	371.474	2.742	14.400	0.004
4802	BASTROP LAKE	0.027	0.090	426.417	12.392	15.000	0.007
4803	BELTON RESERVOIR	0.016	0.195	376.312	8.025	15.000	0.007
4804	BRAUNIG LAKE	0.136	0.250	461.625	22.762	14.800	0.062
4805	BROWNWOOD LAKE	0.027	0.100	470.375	4.887	14.400	0.007
4806	LAKE BUCHANAN	0.026	0.250	427.625	6.600	15.000	0.012
4807	CADDO LAKE	0.055	0.070	461.333	14.800	11.400	0.011
4808	CALAVERAS LAKE	0.038	0.060	461.667	22.500	13.000	0.007
4809	CANYON RESERVOIR	0.010	0.450	394.412	2.500	14.800	0.006
4810	LAKE COLORADO CITY	0.042	0.090	473.625	12.475	10.200	0.012
4811	CORPUS CHRISTI LAKE	0.113	0.130	475.167	19.756	14.800	0.122
4812	DIVERSION LAKE	0.025	0.090	470.111	15.467	9.800	0.009
4813	EAGLE MOUNTAIN LAKE	0.026	0.070	459.625	5.662	11.000	0.008
4814	FT PHANTOM HILL LAKE	0.060	0.105	474.909	6.317	9.400	0.022
4815	GARZA LITTLE ELM RESERVO	0.045	0.380	475.702	14.156	14.600	0.010
4816	KEMP LAKE	0.023	0.110	455.000	10.217	10.400	0.007
4817	HOUSTON LAKE	0.097	0.240	486.287	16.450	12.400	0.036
4818	LAKE O' THE PINES	0.031	0.090	440.000	12.429	15.000	0.011
4819	LAVON RESERVOIR	0.083	0.190	485.333	5.400	8.000	0.019
4820	LIVINGSTON LAKE	0.196	0.555	465.444	16.112	15.250	0.126
4821	LYNDON B JOHNSON LAKE	0.042	0.420	456.500	8.100	14.950	0.013
4822	MEDINA LAKE	0.010	0.400	413.562	12.444	15.400	0.004
4823	LAKE MEREDITH	0.021	0.070	434.312	3.137	14.400	0.004
4824	PALESTINE LAKE	0.031	0.180	442.625	10.619	14.000	0.010
4825	POSSUM KINGDOM RESERVOIR	0.023	0.070	474.045	5.495	15.200	0.004
4826	SAN ANGELO RESERVOIR	0.044	0.140	431.200	24.675	10.250	0.011
4827	SAM RAYBURN RESERVOIR	0.024	0.150	434.492	6.267	15.000	0.009
4828	E V SPENCE RESERVOIR	0.026	0.080	462.563	11.775	15.000	0.004

LAKE DATA TO BE USED IN ANALYSES

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P
4829	SOMERVILLE LAKE	0.053	0.115	473.633	24.491	13.066	0.011
4830	STAMFORD LAKE	0.073	0.280	482.714	18.457	[illegible]	0.012
4831	STILLHOUSE HOLLOW RESERV	0.031	0.240	486.250	3.917	15.000	0.010
4832	TAWAKONI LAKE	[illegible]	0.100	464.417	18.241	13.200	0.013
4833	TEXARKANA LAKE	0.104	0.120	476.500	19.119	12.400	0.030
4834	TEXOMA LAKE	0.042	0.190	451.321	12.443	15.000	0.010
4835	TRAVIS LAKE	0.010	0.250	309.413	5.595	15.000	0.007
4836	TRINIDAD	0.300	0.110	471.500	24.380	10.000	0.244
4837	TWIN BUTTES RESERVOIR	0.029	0.250	494.917	8.708	14.000	0.009
4838	WHITE ROCK RESERVOIR	0.080	0.110	434.500	4.333	15.086	0.009
4839	WHITNEY LAKE	0.029	0.120	438.500	6.962	15.000	0.004

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P	INDEX NO
4801	AMISTAD LAKE	95 (36)	5 (2)	100 (38)	100 (38)	39 (14)	63 (23)	402
4802	BASTROP LAKE	79 (30)	74 (28)	34 (13)	47 (18)	17 (0)	92 (34)	343
4803	BELTON RESERVOIR	92 (35)	26 (10)	97 (37)	68 (26)	17 (0)	84 (32)	384
4804	BRAUNIG LAKE	5 (2)	42 (16)	50 (19)	3 (1)	45 (17)	5 (2)	150
4805	BROWNWOOD LAKE	66 (25)	76 (29)	29 (11)	87 (33)	58 (22)	84 (32)	400
4806	LAKE BUCHANAN	47 (18)	21 (7)	74 (28)	63 (24)	17 (0)	39 (14)	261
4807	CADDO LAKE	26 (10)	87 (33)	42 (16)	32 (12)	76 (29)	34 (13)	297
4808	CALAVERAS LAKE	45 (17)	100 (38)	47 (18)	11 (4)	67 (25)	92 (34)	362
4809	CANYON RESERVOIR	95 (36)	8 (3)	95 (36)	97 (37)	45 (17)	97 (37)	437
4810	LAKE COLORADO CITY	39 (14)	76 (29)	26 (10)	42 (16)	88 (33)	39 (14)	310
4811	CORPUS CHRISTI LAKE	8 (3)	42 (16)	18 (7)	13 (5)	61 (23)	8 (3)	150
4812	DIVERSION LAKE	66 (25)	82 (31)	32 (12)	29 (11)	97 (37)	63 (24)	372
4813	EAGLE MOUNTAIN LAKE	71 (27)	87 (33)	34 (13)	79 (30)	79 (30)	76 (29)	426
4814	FT PHANTOM HILL LAKE	24 (9)	66 (25)	21 (8)	74 (28)	95 (36)	16 (6)	296
4815	GARZA LITTLE ELM RESERVOIR	34 (13)	13 (5)	16 (6)	34 (13)	55 (21)	21 (7)	173
4816	[illegible] LAKE	76 (29)	61 (23)	55 (21)	55 (21)	84 (32)	92 (35)	423
4817	HOUSTON LAKE	16 (6)	16 (6)	0 (0)	24 (9)	72 (27)	11 (4)	139
4818	LAKE OF THE PINES	53 (20)	76 (29)	66 (25)	39 (15)	17 (0)	45 (17)	296
4819	LAVON RESERVOIR	21 (8)	29 (11)	3 (1)	84 (32)	100 (38)	21 (7)	258
4820	LIVINGSTON LAKE	3 (1)	3 (1)	39 (15)	26 (10)	17 (0)	3 (1)	91
4821	LYNDON B JOHNSON LAKE	39 (14)	11 (4)	53 (20)	66 (25)	74 (28)	37 (14)	280
4822	MEDINA LAKE	89 (34)	8 (0)	89 (34)	37 (14)	17 (0)	100 (38)	342
4823	LAKE MEREDITH	82 (31)	91 (33)	71 (27)	95 (36)	39 (14)	63 (23)	441
4824	PALESTINE LAKE	58 (20)	32 (12)	63 (24)	53 (20)	45 (17)	51 (19)	302
4825	POSSUM KINGDOM RESERVOIR	74 (28)	87 (33)	84 (32)	58 (22)	17 (0)	55 (21)	367
4826	SAN ANGELO RESERVOIR	13 (5)	45 (17)	8 (3)	8 (3)	84 (32)	45 (17)	201
4827	SAM RAYBURN RESERVOIR	58 (22)	39 (15)	68 (26)	74 (28)	17 (0)	63 (23)	319
4828	E V SPENCE RESERVOIR	50 (19)	82 (31)	45 (17)	50 (14)	17 (3)	76 (29)	321

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500- MEAN SEC	MEAN CHLORA	15- MIN DO	MEDIAN DISS ORTHO P	INDEX NO
4829	SOMERVILLE LAKE	29 (11)	55 (21)	24 (9)	3 (1)	67 (25)	28 (10)	206
4830	STAMFORD LAKE	18 (7)	97 (37)	5 (2)	18 (7)	82 (31)	39 (15)	259
4831	STILLHOUSE HOLLOW RESERV	88 (33)	37 (14)	87 (33)	92 (35)	17 (6)	51 (19)	372
4832	TAWAKONI LAKE	32 (12)	76 (29)	37 (14)	21 (8)	63 (24)	33 (12)	262
4833	TEXARKANA LAKE	11 (4)	51 (19)	13 (5)	16 (6)	72 (27)	13 (5)	176
4834	TEXOMA LAKE	39 (15)	34 (13)	61 (23)	45 (17)	17 (6)	21 (8)	217
4835	TRAVIS LAKE	80 (30)	21 (8)	92 (35)	82 (31)	17 (6)	84 (32)	376
4836	TRINIDAD	0 (0)	61 (23)	11 (4)	5 (2)	92 (35)	0 (0)	169
4837	TWIN BUTTES RESERVOIR	59 (22)	24 (9)	58 (22)	61 (23)	46 (17)	63 (23)	311
4838	WHITE RIVER RESERVOIR	42 (16)	61 (23)	76 (29)	89 (34)	17 (6)	63 (24)	348
4839	WHITNEY LAKE	63 (24)	51 (19)	79 (30)	71 (27)	17 (6)	76 (29)	357

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	4809	CANYON RESERVOIR	446
2	4823	LAKE MEREDITH	441
3	4813	EAGLE MOUNTAIN LAKE	438
4	4819	KEMP LAKE	423
5	4801	AMISTAD LAKE	402
6	4805	BROWNWOOD LAKE	394
7	4802	BASTROP LAKE	393
8	4838	WHITE ROCK RESERVOIR	390
9	4825	POSSUM KINGDOM RESERVOIR	387
10	4835	TRAVIS LAKE	384
11	4803	BELTON RESERVOIR	384
12	4831	STILLHOUSE HOLLOW RESERV	372
13	4830	SOMERVILLE LAKE	372
14	4808	CALAVERAS LAKE	362
15	4839	WHITNEY LAKE	357
16	4822	MEDINA LAKE	342
17	4827	SAM RAYBURN RESERVOIR	322
18	4829	E V SPENCE RESERVOIR	321
19	4837	TWIN BUTTES RESERVOIR	311
20	4810	LAKE COLORADO CITY	310
21	4824	PALESTINE LAKE	302
22	4821	LAKE OF THE PINES	298
23	4807	CADDO LAKE	297
24	4814	FT PHANTOM HILL LAKE	296
25	4806	LAKE BUCHANAN	261
26	4833	STAMFORD LAKE	259
27	4820	LAVON RESERVOIR	256
28	4832	TAWAKONI LAKE	253

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LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
29	4821	LYNDON B JOHNSON LAKE	238
30	4834	TEXOMA LAKE	217
31	4829	SOMERVILLE LAKE	208
32	4826	SAN ANGELO RESERVOIR	200
33	4833	TEXARKANA LAKE	176
34	4815	GARZA LITTLE ELM RESERVOIR	173
35	4836	TRINIDAD	164
36	4804	BRAUNIG LAKE	159
37	4811	CORPUS CHRISTI LAKE	155
38	4817	HOUSTON LAKE	139
39	4828	LIVINGSTON LAKE	91

CONVERSION FACTORS

Hectares × 2.471 = acres

Kilometers × 0.6214 = miles

Meters × 3.281 = feet

Cubic meters × 8.107×10^{-4} = acre/feet

Square kilometers × 0.3861 = square miles

Cubic meters/sec × 35.315 = cubic feet/sec

Centimeters × 0.3937 = inches

Kilograms × 2.205 = pounds

Kilograms/square kilometer × 5.711 = lbs/square mile

#4

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR TEXAS 10/30/76

LAKE CODE 4837 TWIN BUTTES RES.

TOTAL DRAINAGE AREA OF LAKE(SQ MI) 6594.1

	SUB-DRAINAGE	NORMALIZED FLOWS(CFS)												
TRIBUTARY	AREA(SQ MI)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
4837A1	6594.1	0.481	0.481	0.538	0.340	0.283	0.456	0.793	0.896	0.823	0.538	0.743	0.651	0.489
4837A2	1570.0	0.043	0.042	0.051	0.272	0.793	0.048	0.011	0.184	0.793	0.147	0.057	0.042	0.285
4837B2	973.0	0.31	0.26	0.28	0.3	0.57	0.75	0.19	0.57	0.79	0.31	0.31	0.31	0.42
4837C1	1025.6	2.089	0.119	0.105	3.111	0.283	0.137	0.088	2.188	0.261	0.132	0.113	0.182	0.329
4837ZZ	1064.7	0.159	0.256	0.158	0.283	0.396	0.340	0.079	0.941	0.481	0.141	0.184	0.161	0.296

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 6594.1 TOTAL FLOW IN = 14.80
SUM OF SUB-DRAINAGE AREAS = 6594.1 TOTAL FLOW OUT = 5.87

MEAN MONTHLY FLOWS AND DAILY FLOWS(CFS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
4837A1	9	74	0.287	7	1.359				
	10	74	0.625	5	0.0				
	11	74	4.960	2	56.634				
	12	74	0.816	7	56.634				
	1	75	0.250	4	36.812				
	2	75	7.823	1	19.822				
	3	75	3.340	2	2.444				
	4	75	1.557	6	2.322	20	1.133		
	5	75	14.150	4	3.171	25	0.878		
	6	75	2.832	22	3.398				
	7	75	1.484	28	2.322				
	8	75	1.699	3	1.614				
4837A2	9	74	33.414	7	0.811				
	10	74	10.274	5	2.124				
	11	74	3.287	2	4.191				
	12	74	1.671	7	1.412				
	1	75	1.246	4	1.416				
	2	75	1.104	1	1.044				
	3	75	0.742	2	1.019				
	4	75	0.566	6	0.651	20	0.510		
	5	75	1.524	4	0.425	25	0.850		
	6	75	1.311	22	0.210				
	7	75	0.254	28	0.201				
	8	75	0.216	3	0.122				

TRIBUTARY FLOW INFORMATION FOR TEXAS [illegible]

LAKE CODE 4817 TWIN BUTTES RES.

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
[illegible]	9	74	2.747	7	1.359				
	10	74	6.540	5	2.435				
	11	74	4.385	2	4.332				
	12	74	3.625	7	3.823				
	1	75	2.473	4	3.288				
	2	75	2.710	1	2.492				
	3	75	2.350	2	2.546				
	4	75	2.039	6	2.808	20	1.869		
	5	75	2.834	4	2.835	25	1.424		
	6	75	1.557	22	1.501				
	7	75	1.331	20	1.415				
	8	75	1.246	3	1.246				
[illegible]	9	74	3.509	7	0.823				
	10	74	5.607	5	0.758				
	11	74	1.642	2	1.588				
	12	74	1.331	7	1.561				
	1	75	1.019	4	0.441				
	2	75	1.076	1	7.133				
	3	75	0.406	2	1.019				
	4	75	0.679	6	0.621	20	0.456		
	5	75	4.332	4	0.595	25	1.104		
	6	75	0.736						
	7	75	0.595	20	0.680				
	8	75	0.300	1	0.510				
[illegible]	9	74	4.248						
	10	74	2.492						
	11	74	0.850						
	12	74	1.416						
	1	75	1.133						
	2	75	1.133						
	3	75	0.227						
	4	75	0.176						
	5	75	0.481						
	6	75	0.425						
	7	75	4.346						
	8	75	0.240						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 79/02/13

403701
31 22 25.0 100 32 35.0
TWIN BUTTES RESERVOIR
48451 TEXAS

11EPALES 2111202
0030 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3+NH4- N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/04	15 30	0000	15.6		40	576	8.40	162	0.040	0.700	0.040	0.004
	15 30	0005	15.6	10.2		572	8.31	159	0.020	0.600	0.030	0.009
	15 30	0015	12.4	9.6		535	8.21	164	0.030	0.500	0.040	0.008
	15 30	0032	12.6	9.6		530	8.20	163	0.030	0.500	0.040	0.009
74/05/15	15 20	0000	25.0		40	748	8.38	156	0.040	0.600	0.040	0.002
	15 20	0005	24.6	7.8		744	8.38	156	0.044	0.500	0.046	0.005
	15 20	0015	24.5	6.8		742	8.38	155	0.023	0.400	0.020	0.002
	15 20	0030	24.0	7.4		733	8.38	156	0.050	0.500	0.050	0.006
74/08/05	11 30	0000	25.8	4.8	50	803	8.25					
	11 30	0005	25.6	5.4		810	8.05					
	11 30	0015	25.8	4.8		810	8.05					
	11 30	0031	25.4	8.2		824	7.85					
74/10/29	10 05	0000	16.7	6.2	40	391	7.72	121	0.040	0.600	0.210	0.027
	10 05	0005	16.7	5.6		391	7.73	121	0.030	0.500	0.210	0.024
	10 05	0020	16.7	5.4		394	7.72	123	0.040	0.500	0.210	0.023
	10 05	0035	16.5	3.2		376	7.71	119	0.050	0.400	0.260	0.032
	10 05	0043	17.3	4.8		272	7.65	102	0.140	0.500	0.290	0.054

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/04	15 30	0000	0.017	5.4	
	15 30	0005	0.017		
	15 30	0015	0.016		
	15 30	0032	0.021		
74/05/15	15 20	0000	0.022	4.6	
	15 20	0004	0.025		
	15 20	0015	0.025		1.0
	15 20	0030	0.024		
74/08/05	11 30	0000		13.7	
	11 30	0014			1.0
74/10/29	10 05	0000	0.053	6.8	
	10 05	0001			50.0
	10 05	0005	0.040		
	10 05	0004			1.0
	10 05	0020	0.043		
	10 05	0035	0.046		
	10 05	0043	0.092		

STORET RETRIEVAL DATE 78/03/11

403702
31 21 28.0 100 32 10.0
TWIN BUTTES RESERVOIR
48451 TEXAS

130PALEST
0
2111202
0047 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
76/02/04	16 05	0000	13.3		48	530	8.30	171	0.040	0.400	0.040	0.009
	16 05	0005	13.2	10.0		530	8.25	162	0.030	0.500	0.040	0.009
	16 05	0015	12.6	9.6		529	8.20	163	0.030	0.500	0.060	0.007
	16 05	0025	12.6	9.6		522	8.20	164	0.030	0.500	0.060	0.006
	16 05	0042	11.2	9.0		512	8.20	162	0.040	0.500	0.040	0.006
76/05/15	15 00	0000	24.6		96	742	8.30	158	0.060	0.400	1.050	0.006
	15 00	0005	24.4	8.8		740	8.30	158	0.050	0.500	1.060	0.007
	15 00	0015	24.0	7.6		737	8.30	159	0.050	0.500	0.670	0.006
	15 00	0037	20.4	6.8		728	8.00	158	0.110	0.400	0.300	0.010
76/08/05	17 00	0000	25.5	6.8	72	880	8.30					
	17 00	0005	25.5	6.2		860	8.00					
	17 00	0015	25.5	6.2		880	7.45					
	17 00	0035	25.2	2.0		884	7.40					
76/10/29	10 40	0000	18.7	6.2	48	393	7.71	124	0.030	0.400	0.250	0.026
	10 40	0005	18.7	5.8		392	7.73	124	0.020	0.500	0.240	0.025
	10 40	0015	18.5	5.8		392	7.64	129	0.030	0.500	0.240	0.023
	10 40	0020	18.5	5.8		392	7.66	134	0.020	0.500	0.250	0.025

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
76/02/04	16 05	0000	0.019	5.0	
	16 05	0005	0.016		
	16 05	0015	0.014		
	16 05	0025	0.014		
	16 05	0042	0.016		
76/05/15	15 00	0000	0.025	7.7	
	15 00	0005	0.025		
	15 00	0015	0.024		
	15 00	0017			1.0
	15 00	0037	0.051		
76/08/05	17 00	0000		12.4	
76/10/29	10 40	0000	0.043	7.2	
	10 40	0001			50.0
	10 40	0005	0.034		
	10 40	0026			1.0
	10 40	0015	0.037		
	10 40	0020	0.044		

STORET RETRIEVAL DATE 76/08/11

403703
31 17 32.0 100 36 00.0
TWIN BUTTES RESERVOIR
48451 TEXAS

11EPALES
0
2111202
0025 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/03/05	10 45	0000	15.3		26	570	8.30	283	0.040	0.400	0.740	0.011
	10 45	0005	15.2	8.0		570	8.30	282	0.020	0.400	0.740	0.008
	10 45	0015	14.8	8.4		570	8.30	282	0.030	0.400	0.750	0.009
	10 45	0020	14.7	8.0		571	8.30	283	0.050	0.500	0.750	0.011
74/05/15	14 15	0000	25.0		30	798	8.25	179	0.060	0.900	0.300	0.005
	14 15	0005	25.7	7.4		784	8.25	178	0.090	0.500	0.330	0.006
	14 15	0017	24.7	7.0		775	8.26	179	0.080	0.500	0.320	0.004
74/08/05	10 30	0000	25.2	6.8	18	850	8.20					
	10 30	0005	25.2	5.6		850	8.10					
	10 30	0010	25.0	5.2		850	8.05					
74/10/24	11 00	0000	16.5	7.2	36	410	7.94	164	0.080	0.600	0.270	0.027
	11 00	0005	16.2	7.2		407	7.92	164	0.090	0.500	0.270	0.020
	11 00	0015	16.0	6.2		402	7.84	164	0.100	0.500	0.270	0.023
	11 00	0024	17.0	5.6		345	7.76	161	0.130	0.600	0.270	0.035

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/03/05	10 45	0000	0.026	3.2	
	10 45	0005	0.025		
	10 45	0015	0.025		
	10 45	0020	0.033		
74/05/15	14 15	0000	0.045	4.8	
	14 15	0005	0.043		1.0
	14 15	0017	0.051		
74/08/05	10 30	0000		16.2	
	10 30	0004			1.0
74/10/24	11 00	0000	0.063	11.3	
	11 00	0001			50.0
	11 00	0005	0.061		
	11 00	0004			1.0
	11 00	0015	0.054		
	11 00	0024	0.061		

81

APPENDIX E

TRIBUTARY DATA

84

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STORET RETRIEVAL DATE 75/09/10
                                                        481741
                                                       31 22 00.0 100 31 20.0 4
                                                       MIDDLE CONCHO RIVER
                                                       48213    TOM GREEN CO MAP
                                                       TWIN BUTTES RESERVOIR
                                                       2NDRY 40 KING 1 MI NW JCT 2NDRY RD 584
                                                       11EPALES          211102
                                                        0000 FEET  DEPTH  CLASS 00

                           00630      00625      00610      00671      00665
  DATE    TIME DEPTH  NO2&NO3   TOT KJEL    NH3-N    PHOS-DIS   PHOS-TOT
  FROM     OF          N-TOTAL      N        TOTAL     ORTHO
   TO     DAY  FEET     MG/L       MG/L      MG/L     MG/L P     MG/L P

 74/09/07 12 00         0.020      0.400     0.070     0.010      0.050
 74/11/02 19 00         0.234      1.085     0.035     0.025      0.056
 74/12/07 11 45         0.404      0.500     0.024     0.024      0.040
 75/01/04 11 20         0.040      0.700     0.024     0.005K     0.320
 75/02/01 11 00         0.400      0.100     0.024     0.014      0.030
 75/03/02 14 00         0.470      0.150     0.025     0.015      0.020
 75/04/06 16 15         0.500      1.290     0.070     0.005      0.010
 75/05/04 15 45         0.373      2.400     0.240     0.010      0.040
 75/05/25 14 00         0.220      0.600     0.015     0.005K     0.056
 75/06/29 14 00         1.720      0.550     0.030     0.005K     0.050
 75/07/26 14 30         0.010      1.100     0.314     0.010      0.030
 75/08/13               0.020      0.400     0.100     0.010      0.040


   K VALUE KNOWN TO BE
   LESS THAN INDICATED
```

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STORET RETRIEVAL DATE 76/03/10
                                                                 483742
                                                                 31 25 30.0 100 42 30.0 4
                                                                 48451 TEXAS
                                                                 48     15 [illegible]
                                                                 TWIN BUTTES RESERVOIR
                                                                 [illegible]
                                                                 11EPALES             2111202
                                                                  0000 FEET  DEPTH  CLASS 00

                              00630     00625     00610     00671     00665
 DATE     TIME DEPTH NO2&NO3  TOT KJEL   NH3-N  PHOS-DIS  PHOS-TOT
 FROM      OF         N-TOTAL    N       TOTAL   ORTHO
  TO      DAY  FEET    MG/L     MG/L     MG/L    MG/L P    MG/L P

74/09/07 09 30         0.024    0.500    0.015    0.010     0.050
74/10/05 08 45         5.040    1.100    0.025    0.005K    0.025
74/11/02 08 55         1.040    0.400    0.020    0.040
74/12/07 09 35         1.700L   0.400    0.015    0.008K    0.030
75/01/04 09 45         4.100    1.100    0.032    0.005K    0.020
75/02/02 12 15         2.500    0.700    0.020    0.020     0.020
75/04/06 14 00         1.300    0.700    0.015    0.005     0.010K
75/04/20 14 05         0.400    0.450    0.025    0.004     0.040
75/05/04 14 00         0.340    0.250    0.025    0.005K    0.020
75/05/25 15 00         0.300    0.400    0.020    0.005K    0.040
75/06/22 13 00         0.010    0.400    0.045    0.005     0.020
75/08/03 13 15         0.005    0.250    0.015    0.010     0.030


  L ACTUAL VALUE IS KNOWN TO BE
  GREATER THAN VALUE GIVEN


  K VALUE KNOWN TO BE
  LESS THAN INDICATED
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STORET RETRIEVAL DATE 76/03/10

402702
31 14 12.0 100 29 55.0 4
SOUTH CONCHO RIVER
48 TOM GREEN CO MAP
TWIN BUTTES RESERVOIR
[illegible]
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3+NH4- N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/07	11 00		1.380	0.300	0.015	0.010	0.015
74/10/05	09 50		2.325	0.700	0.015	0.005K	0.010K
74/11/02	09 35		2.320	0.700	0.060	0.015	0.060
74/12/07	10 30		0.110	0.300	0.005	0.004	0.015
75/01/04	10 50		3.000	0.700	0.024	0.005K	0.032
75/02/01	10 20		2.400	0.750	0.032	0.004	0.012
75/03/02	13 30		2.300	0.750	0.015	0.005	0.010K
75/04/06	15 45		2.290	0.550	0.025	0.005K	0.010K
75/04/29	16 07		2.000	0.650	0.015	0.005	0.010K
75/05/04	15 10		1.800	0.500	0.030	0.005	0.020
75/05/25	16 00		1.400	0.250	0.020	0.005K	0.040
75/06/22	15 00		1.000	1.300	0.060	0.005K	0.040
75/07/20	15 30		1.050	0.350	0.030	0.005K	0.010K
75/08/03	14 30		1.720	0.325	0.020	0.005	0.015

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/03/10

[illegible]
[illegible]
[illegible]
[illegible] RIOGRANDE RIVER
[illegible] BUTTES RESERVOIR
[illegible]
[illegible] 211112
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/07	10 30		1.250	0.380	0.030	0.005	0.010
74/10/05	09 30		1.360	0.590	0.025	0.005K	0.010K
74/11/02	09 25		1.600	0.380	0.025	0.015	0.025
74/12/07	10 10		1.130L	0.380	[illegible]	[illegible]	0.010K
75/01/04	10 20		[illegible]	0.760	0.016	0.005K	0.010K
75/02/01	10 00		1.940	0.200	0.024	[illegible]	0.010K
75/03/02	13 00		1.380	1.050	0.015	0.010	0.016
75/04/06	15 20		3.200	0.590	0.010	0.005K	0.015K
75/04/28	15 30		2.700	0.350	0.029	0.005	0.010K
75/05/04	14 45		2.700	0.400	0.025	0.005	0.020
75/05/25	15 30		2.600	0.250	0.010	0.005K	0.021
75/06/22	14 30		2.460	0.350	0.025	0.005	0.030
75/07/20	15 15		2.435	0.200	0.020	0.005K	0.030
75/08/03	14 00		2.750	0.200	0.010	0.005	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

L ACTUAL VALUE IS KNOWN TO BE
GREATER THAN VALUE GIVEN

STORET RETRIEVAL DATE 76/03/10

463701
31 19 45.0 100 30 20.0 4
SPRING CREEK
48 15 KNICKERBOCKER
TWIN BUTTES RESERVOIR
200 YDS DOWNSTREAM BELOW DAM SPILLWAY
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3+NH4- N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/09/07	10 15		0.020K	1.000	0.025	0.005	0.240
74/10/05	09 15		0.490	0.400	0.015	0.005K	0.010
74/11/02	09 15		0.040	0.700	0.045	0.015	0.070
74/12/07	09 45		1.100L	0.950	0.570	0.005K	0.015
75/01/04	10 15		4.100	1.200	0.080	0.005K	0.010K
75/02/01	09 45		4.400	0.400	0.040	0.004	0.020
75/03/02	12 45		4.200	0.450	0.015	0.010	0.010
75/04/06	15 00		3.200	1.050	0.590	0.005	0.010K
75/04/20	15 30		2.750	0.450	2.020	0.005K	0.310K
75/05/04	14 30		1.900	0.450	0.045	0.005	0.030
75/05/25	15 45		2.200	0.450	0.040	0.005K	0.040
75/07/25	15 00		1.500	0.400	0.030	0.005K	0.030
75/08/13	13 45		1.450	0.400	0.045	0.010	0.040

K VALUE KNOWN TO BE
LESS THAN INDICATED

L ACTUAL VALUE IS KNOWN TO BE
GREATER THAN VALUE GIVEN